Space Sciences Laboratory
University of California
Berkeley, California 94720

Semi-Annual Report on

STUDY OF GROWTH IN RECENT AND FOSSIL INVERTEBRATE EXOSKELETONS AND ITS RELATIONSHIP TO TIDAL CYCLES IN THE EARTH-MOON SYSTEM

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Principal Investigator: Professor W. B. N. Berry

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INTRODUCTION

Shells of many pelecypod species consist of numerous growth layers (revealed most clearly in thin section) that may be related to fortnightly tides, day-night changes, and other regular cycles. The goals of this investigation are to elucidate these relationships among recent forms and to obtain numerical relationships between identical growth layers in fossil shells. As discussed below, the growth layer counts that have been made so far lead to an unexpected conclusion regarding deceleration of the earth and moon.

COUNTS OF GROWTH LAYERS IN FOSSILS

In order to estimate the periodicities of shell growth cycles, it is necessary to define the sample populations. Last year rather high averages were obtained from counts in which the anomalously crinkled elemental layers were included. Since this study is concerned with normalities of shell growth, growth line counts have been confined to sequences that are not complicated by disturbance rings. Further refinement of sampling technique was necessary, in that many fossil specimens have provided only single cycles or parts of cycles. Periodicities have been estimated most accurately when an unbroken count of the finer layers was made of several larger-scale layers. The summary of determinations shown in Table 1 refers to analyses of contiguous layers of normal shell.

SIGNIFICANCE OF RESULTS

Assuming that the length of the year has been constant, the data obtained so far indicate a lengthening day, at a rate of 2.7 seconds per 100,000 years. This value is of the right order of magnitude to agree with some of the astronomic measurements of historic times.

Generally it has been assumed that the lengthening day has resulted from tidal friction between the earth, the moon, and the sun. Because tidal friction depends upon the extensiveness of the ocean, the lengthening of the day would have occurred most rapidly during times of widespread seas and more slowly during regressions. However, this does not seem to be the case, for when the data of Devonian tetracoral studies are plotted alongside the Cretaceous and Carboniferous pelecypod data and against geological time, a straight line results (Figure 1). This seems to indicate that the change in the length of the day has occurred very uniformly; and, since it is known that the distribution of shallow seas has varied greatly from one geologic epoch to another, it seems certain that tidal friction has not been the chief factor in earth deceleration. Considering that there is no geological evidence for the occurrence of great changes in the earth's mass, it would follow from the law of conservation of angular momentum that the lengthening of the day has been induced by an increase in the earth's radius.

STUDY OF GROWTH IN RECENT FORMS

Growth experiments at the University of California Marine Biology Laboratory and regular field studies have been discussed in previous reports. Some additional data are being gathered from the biological collections of the California Academy of Sciences. It is apparent that there may be some correlation between growth layering, season of collection, and gonadal development.

STUDY MATERIAL FROM THE GULF COAST REGION

Exposures of the Ripley Formation along the banks of Coon Creek in Tennessee (located in the southwestern part of the state, near Adamsonville) include a sandy marl in which the remains of shallow water mollusks are very abundant. These fossils, probably the best preserved Cretaceous shells to be found in North America, have been studied in thin section with signal success. Some Ripley fossils were obtained previously from a commercial collector, but the number of specimens was inadequate for statistical study. For this reason, and

in order to make field observations of the occurrence of Ripley fossils, it was imperative that the Coon Creek outcrops be studied; this was done by Mr. Richard Barker.

Among the fossils collected were a dozen large pelecypod shells identified as Cucullaea vulgaris, several hundred Corbula crassiplicata, and hundreds of other fossil pelecypods that can be utilized for thin section study of sub-annual growth layers.

Additional suitable Late Cretaceous fossils have been borrowed from the U.S. National Museum. Members of that institution and of the U.S. Geological Survey have contributed fossil materials for thin sectioning.

CONCLUSION

The study of cyclic growth layering in pelecypod shells is progressing toward increased knowledge of the environmental variables of present and prehistoric biorhythmicities. The evidence available now suggests strongly that changes in the lengths of the day and the month have occurred slowly and uniformly during the past 310 million years; tidal friction alone is insufficient to account for circular motion changes in the earth-moon system. Many fossils critical to this study have been collected and are being processed to obtain statistically significant data.

PUBLICATIONS

1. Fossil Shell-Growth Layering, and the Periods of the Day and Month During Late Paleozoic and Mesozoic Time. Richard Barker. Presented at the meeting of the Geological Society of America, San Francisco, November 1966.

2. Cyclic Banding in Fossil Pelecypod Shells (in preparation).

3. Fossil Shell-Growth Layering, and the Periods of the Day and Month During Late Paleozoic and Mesozoic Time (tentative title). Scientific Research, April 1967 (in press).

PERSONNEL

Professor W. B. N. Berry	—	Principal Investigator
Professor J. Wyatt Durham	—	Associate Investigator
Dr. Charles R. Stasek	—	Special Advisor
Richard Barker	—	Post Graduate Research Paleontologist

TABLE 1

Geological time	Apparent days per year*	Apparent months per year	Apparent days per month
Late Cretaceous (80 m.y.a.)**	373	12.52 ± 0.03 (5 specimens)	29.82 ± 0.21 (13 specimens)
Carboniferous (310 m.y.a.)	?	12.90 ± 0.02 (3 specimens)	?

*Calculated by multiplying months per year by days per month

**m.y.a.: millions of years before present

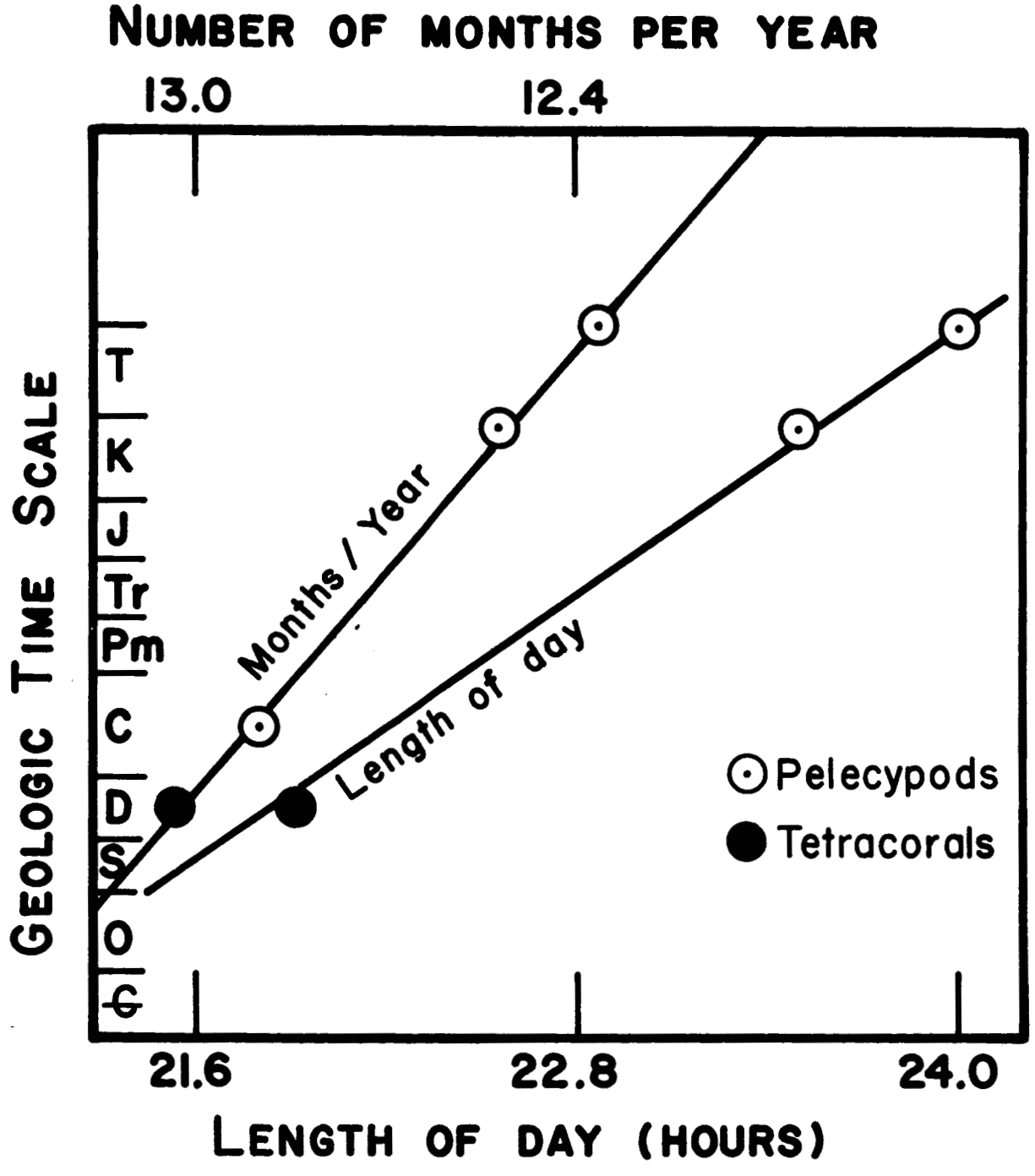
NUMBER OF MONTHS PER YEAR
13.0
12.4
GEOLOGIC TIME SCALE
T
K
J
Tr
Pm
C
D
S
O
Cm
Months / Year
Length of day
Pelecypods
Tetracorals
21.6
22.8
24.0
LENGTH OF DAY (HOURS)

FIGURE ONE